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Extra-short implants in the posterior region: A case series of single and multi-unit fixed prostheses

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KEYWORDS Dental implants; Extra-short implants; Survival rate; Implant-supported dental prosthesis; Dental restoration failure.

ABSTRACT

Aim Anatomical and surgical conditions may require the use of implants with reduced length. This study reports a case series of patients treated with single or multi-unit fixed prostheses supported by 4-mm implants in the posterior region. The aim was to describe the success rate up to four years of loading, and the mechanical and biological complications.

Materials and methods The sample consisted of all patients treated with prostheses supported by 4-mm implants at the Military Policlinic of Porto Alegre, Brazil, between the years 2015 and 2019. The patients were recalled for clinical examination and data collection: The type of prosthesis, maximum bite force, presence of bruxism, peri-implant bone level, and crown-implant ratio were recorded.

Results Eight patients with 19 implants in the premolar and molar region were examined. Eleven implants were rehabilitated with single crowns and 8 with splinted crowns. The implant survival rate was 100%, with a mean follow-up of 33.8 ± 10.6 months after surgery. There were 6 (2 non-splinted) cases of prosthetic screw loosening, resulting in a prosthetic complications rate of 27.3%, with an average follow-up of 28.6 ± 10.86 months after prosthesis installation.

Conclusions Within the study limitations, it can be concluded that 4-mm implants show high survival but also relevant occurrence of prosthetic complications.

INTRODUCTION

In recent years, technological innovations improved the surface treatment and macro- and micro-geometry of short implants (less than 10-mm-long), which has led to a successful clinical performance even in the posterior region, where the bone quality and quantity are often poor and masticatory forces are high (1-6).

The 4-mm implants, generally classified as extra-short implants, have been used in the rehabilitation of cases with severe bone resorption, particularly to avoid bone grafting and other complex surgical procedures. Besides the biomechanical challenges of reduced bone support, a few studies on extra-short 4-mm implants have shown success rates ranging from 91.6 to 97.5% up to 5 years of follow-up, with no statistically significant differences to conventional height implants (10-mm) (5,7,8). However, these previous papers reported the short-term clinical performance after one year of loading.

This study reports a case series of patients treated with single or multi-unit fixed prostheses supported by extra-short (4-mm long) implants in the posterior region. The aim was to describe the success rate up to 4 years of loading, mechanical and biological complications, considering selected clinical factors: single or multi-unit prosthesis, crown-implant ratio, maximum bite force, and presence of bruxism.

MATERIALS AND METHODS

The study design was a retrospective case series, with clinical and radiographic examination up to 4 years after prosthesis installation. The research project followed the precepts of the Declaration of Helsinki and was approved by the University Research Ethics Committee (CAAE 03434118.9.0000.5336) and by the Ethics Committee of the Military Polyclinic of Porto Alegre (Session 001 - 06/29/2018 - ATA 001).

Patients

A consecutive sample was obtained from the patients

treated at the Implantology Service, Dentistry Division of the Military Policlinic of Porto Alegre, in Porto Alegre, Brazil, between the years 2015 and 2019. The clinical charts of patients who received prosthesis supported by extra-short implants (4-mm long and diameter of 4.1-mm) in the posterior region of the maxilla and/or mandible were retrieved for preliminary analysis of eligibility. The exclusion criteria were: history of chemotherapy and/or local radiation therapy; bone graft procedures before or simultaneously with implant insertion; presence of active periodontal disease in the remaining teeth in the last recall visit.
The patients who met the eligibility criteria were contacted by phone and invited to attend a clinical appointment for data collection. All patients who accepted to participate in the study voluntarily signed an informed consent form.

Clinical examination

Each patient answered a standardized structured questionnaire to collect socio-demographic, medical and dental variables. Data on the surgical procedure, prosthesis fabrication and installation, and previous radiographic exams were collected from the patient's clinical chart and confirmed during the face-to-face interview by a single trained examiner (D.B.S.).
On physical examination, data were collected on the peri-implant health conditions, occlusal pattern, presence of wear facets, and functional status of the prosthesis on the implant.

Bruxism and maximum occlusal force

The self report of probable bruxism was obtained with a questionnaire adapted from Winoccour et al. (2011) (9), yielding a dichotomous variable (yes/no) for the presence of sleep bruxism.

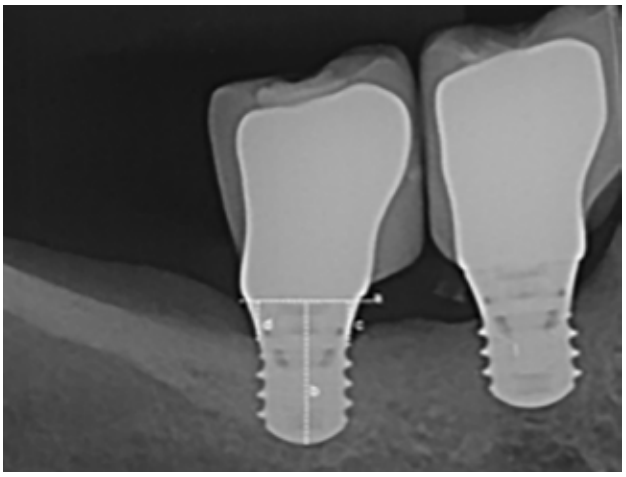

FIG. 1 Measurements: Implant platform line (a), implant measurement (apex of the implant to the implant neck) (b), mesial height of the platform line to the most coronal contact point of the bone / implant (c), distal height from the platform line to the most coronal contact point of the bone/implant (d).

For the measurement of the maximum occlusal force, a portable equipment with a cross-arch compressive force transducer (Sensotec 13/2445-02, United States) was used (10). After preliminary training, the patient was asked to bite for three times as hard as possible, and the maximum bite force was computed as the arithmetic mean of the three values.

Marginal bone level

A digital periapical radiograph was taken at the time of patient recall. The parallelism technique with long cone was used, with radiographic positioners. The Image Plate phosphor plate (Dürr Dental SE, Germany), the Vista Scan Mini Plus digitizer device (Dürr Dental SE, Germany), and the Viewbox Studio software, version 0.15.0.0 (Viewbox Software, Brazil) were used for image acquisition with the X-ray machine Timex 70 E Pantographic Mobile Column 70 KvP 7mA (SAEVO, Brazil). The exposure time was 0.63 seconds for premolars and molars, for both the maxilla and mandible.
Using the Adobe Photoshop CC 2018 computer program (version 19.1.5), the measurements was made with a previous calibration, measuring the apex of the implant to the base (4 mm) and also, the neck of the implant (1.8 mm) and after this calibration the marginal bone level was linearly measured in relation to the implant platform. The measurements were made in the mesial and distal regions, calculating the average of the two faces, according to previous studies (2,11) (Fig. 1).

Crown/implant ratio

The periapical radiographic images were used to compute the anatomical and clinical crown/implant ratio (2). The anatomical crown was measured from the implant platform to the highest cusp, in millimeters. The clinical crown was measured from the most coronal bone-implant contact (mean between mesial and distal sides) to the highest cusp of the crown. The implant measurement was defined as the distance from the most coronal bone-implant contact to implant apex.
The measurement of the crown was divided by the measurement of the implant to obtain the crown/implant ratio (Fig. 2).

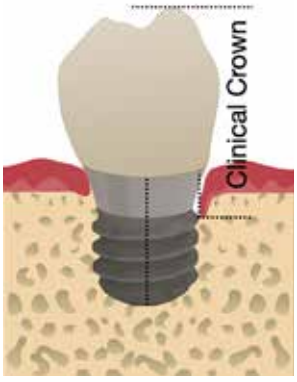

FIG. 2 The clinical crown was measured from the most coronal bone-implant contact (mean between mesial and distal sides) to the highest cusp of the crown.

	Count	Mean	SD	[Min – Max]
Patient	08			
Female	07			
Male	01			
Age (years)		57,22	7,74	[47 – 73]
Maximum occlusal force (N)		403,15	116,15	[275.8 – 564.9]
Bruxism – absent	5			
Bruxism – present	5			
4-mm Implant	19			
Implant Site				
Premolar	07			
Molar	12			
Implant (type of prosthesis)				
Non-splinted (single)	11			
Splinted (multi-unit)	11			
Occlusal contact				
Absent	03			
Present	6			
Implant position				
Distal	07			
Intermediate	12			
Anatomical C/I ratio		1.93	0.26	[1.4 – 2.4]
Clinical C/I ratio		4.05	1.07	[2.2 – 5.9]
Marginal bone level (mm)		2.33	0.60	[1.0 – 3.1]

TABLE 1 Description of the demographic and clinical data of the study sample.

Statistical analysis

Data were analyzed with descriptive statistics by using the SPSS® software (IBM Corporation, Armonk, NY, USA).

RESULTS

The sample of 8 patients received 19 extra-short implants (4-mm long, Straumann Dental Implant System; Standard Plus Implant, diameter 4.1., Regular neck, SLA active, Roxolid). Metal-ceramic implant-supported prostheses were screwed on a synOcta® abutment following the manufacturer's recommendations for torque: 35Ncm for abutment and 15Ncm for prosthetic screw.

The descriptive statistics of the sample are shown in Table 1. Implant survival rate was 100% with an average follow-up of 33.8 ± 10.6 months (18 to 48 months) after surgery. Figure 3 shows examples of radiographs for single and splinted 4-mm implants.

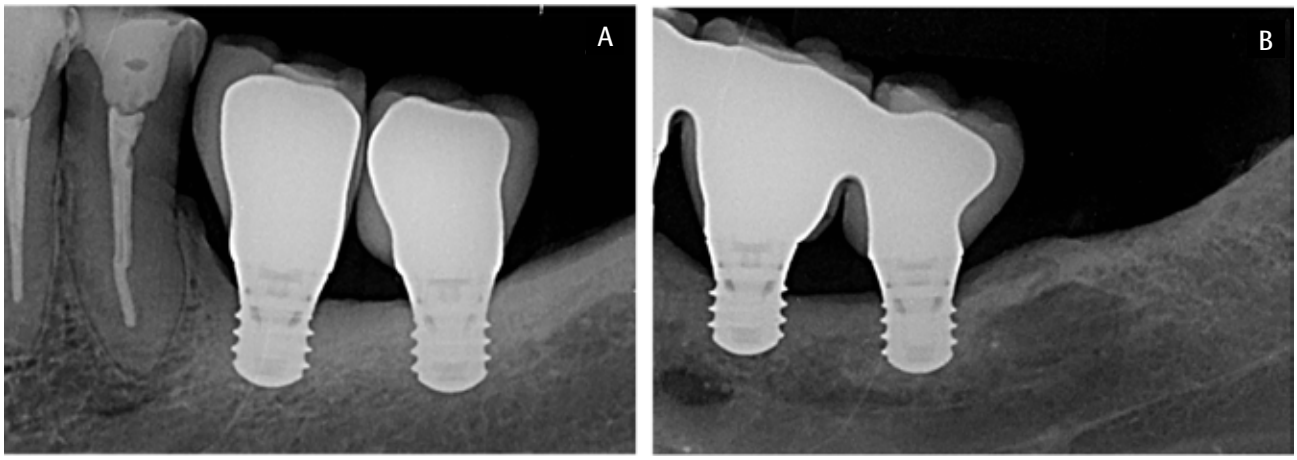

FIG 3 Single crowns at the 16-month clinical follow-up after installation of the prosthetic crown (a), splinted crowns at the 6-month clinical follow-up after installation of the prosthetic crown (b).

Patient	Maximum Occlusal Force (N)	Bruxism	Dental site	Time to event	Implant	Anatomical C/I	Clinical C/I	Marginal bone level (mm)
# 1	533.8	no	34	17 months	Splinted	2.22	5.13	2.75
			35	17 months	Splinted	2.33	4.76	2.45
			36	17 months	Splinted	2.00	2.91	1.35
# 2	564.9	yes	47	23 months	Splinted	2.40	5.91	2.95
# 3	280.2	yes	45	7 days	Non-splinted	2.09	5.75	3.15
# 4	493.7	no	45	7 months	Non-splinted	1.95	3.96	2.35

TABLE 2 Description of implants that had prosthetic complications (loosening of prosthetic screw on synOcta®) (n = 6).

Table 2 displays the cases of prosthetic complications. Six cases of prosthetic screw loosening on the synOcta® abutment occurred in four patients, resulting in a rate of prosthetic complications of 27.3% with an average follow-up of 28.6 ± 10.86 months (12 to 43 months) after prosthesis installation. Loosening of the prosthetic screw occurred in both splinted and non-splinted implants, in the premolar and molar regions, from 7 days to 23 months of function.

DISCUSSION

The present study showed that the use of extra-short 4-mm implants has good clinical performance in the posterior region, with a survival rate of 100% of the implants up to four years of loading. Although the literature on 4-mm implants is limited, our findings are consistent with previous studies that showed survival rates above 90% for implants shorter than 6-mm at follow-up of 1 to 5 years (5,7,8,12). The prosthetic success rate of 72.7%, according to the criteria adopted by the study (13), is compatible with the rate of 62.5% up to 4 years in 6-mm implants supporting single crowns (2), where the same success criteria and methodological procedures were used. However, the literature is not clear about the distinction between success and survival rates, and data regarding complications and prosthetic failures are not reported in many clinical studies (1,4,6). The mean peri-implant bone level was 2.33 mm and fits the success criteria adopted by the study. Considering that the implants were installed with the treated surface at the bone level and the 1.8-mm platform, an average bone remodeling of 0.62mm was estimated, which is within the literature standards for this implant design (2,7,11,14).

All cases of prosthetic complications (27.3%) were prosthetic screw loosening, which is in accordance with the current literature (15). The abutment used has a double screwing system, which may cause the prosthetic screw to receive a lower torque (15Ncm) and consequently a lower preload, resulting in a more unstable system independently from the prosthetic connection (16). Probably this situation led to hybrid restorations, i.e., zirconia crowns cemented on a titanium base, being directly screwed on the implant internal connection with a 35N maximum torque to avoid screw loosening.

Among the six 4-mm implants with prosthetic complications, 4 implants were splinted to support multi-unit prostheses, and two implants supported single crowns. In this sample, 11 out of 19 implants were rehabilitated with non-splinted prostheses. Splinting the implants through the dental prosthesis has been previously investigated (3,4,6,12). A recent finite elements study showed that the splinting of implants reduces the stress in implants, prosthetic components, and peri-implant cortical bone (17). However, other studies on implants with 6-, 7-, 8.5-, 10-, and 11-mm in length did not find any differences in bone loss between splinted and non-splinted implants (18,19). In a split-mouth study with splinted and non-splinted 6- to 11-mm implants, symmetrically inserted in the same arch, Clelland et al. (18) found no difference regarding marginal bone loss in a 3-year follow-up; however, all cases of screw loosening occurred in non-splinted prostheses. Nevertheless, the clinical evidences still are scarce regarding extra-short 4-mm implants and with longer follow-up.

Among the four patients who had prosthetic complications, two reported possible bruxism and three had a maximum bite force greater than the sample average. Although mechanical incidents are more common than biological problems, the role of occlusal overload in the prognosis of implant-supported prostheses still is controversial due to the scarcity of controlled studies and conflicting literature (1,2,20,21), and the challenging diagnosis for real bruxism (22) as well.

The average anatomical C/I ratio was 1.93 and the clinical C/I ratio was 4.05. All six implants with prosthetic complications had an anatomical C/I ratio higher than the average, and four implants had a clinical C/I ratio higher than the average. These findings can be explained by the fact that the anatomical C/I ratio is more linked to the tension at the implant-prosthesis interface,

regardless of bone level. On the other hand, the higher clinical C/I ratio may be related to increased tension in the bone adjacent to the most cervical region of the implant, being proportional to the leverage exerted by the crown height plus the supra-bone implant length, which could cause greater local bone loss (2,23). Finite element analysis showed a tendency that the greater the crown height, the greater the tension in the cortical bone adjacent to the implant (23). However, other studies with different methodologies have not found this relationship (11,14,24). Villarinho et al. (2) demonstrated an association between C/I ratio and bone loss over time in 6-mm implants.

Due to the study limitations of retrospective design and small sample size, inferential statistical tests could not be used to analyze the effect of technical and biological variables on clinical outcome measures. Therefore, prospective studies with a larger sample of 4-mm implants and long-term follow-up are necessary to investigate the risks for prosthetic and biological complications.

In summary, the findings suggest a successful rehabilitation of the edentulous posterior region with 4-mm long implants supporting both splinted and non-splinted prostheses. Although prosthetic screw loosening was frequent, this prosthetic complication is easily resolved in one clinical appointment.

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Conflict of interest

The authors declare no conflict of interest.

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